



Startup

Servo Drive AX5000

(60 A – 170 A)

Please read this document carefully before installing and commissioning the servo drive.

Version: 1.6

Date: 2015-06-23

Language: English

Article no.: TDmIAX-5160-0000-0200



BECKHOFF

Notes:

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1 Foreword

1.1 Notes on the documentation

This description is only intended for trained specialists in control, automation and drive engineering who are familiar with the applicable national standards. It is essential that the following notes and explanations are followed when installing and commissioning these components. The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards. The "General safety instructions" and "Special safety instructions for AX5000" sections are also essential.

1.2 Disclaimer

The documentation has been prepared with care. The products described are, however, constantly under development. For this reason, the documentation may not always be have been fully checked for consistency with the performance data, standards or other characteristics described. In the event that it contains technical or editorial errors, we retain the right to make alterations at any time and without warning. No claims for the modification of products that have already been supplied may be made on the basis of the data, diagrams and descriptions in this documentation.

1.3 Trademarks

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1.4 Patent Pending

The EtherCAT Technology is covered, including but not limited to the following patent applications and patents:

EP1590927, EP1789857, DE102004044764, DE102007017835

with corresponding applications or registrations in various other countries.

The TwinCAT Technology is covered, including but not limited to the following patent applications and patents:

EP0851348, US6167425 with corresponding applications or registrations in various other countries.

1.5 Copyright

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1.6 Documentation issue status

| Version | Comment |
|---------|--|
| 1.6 | Chapter-Update: 4.4.2 |
| 1.5 | Chapter-Update: 4.5; 4.6; 4.7; 4.8.2. |
| 1.4 | New Chapter: 5.2.1.2 Chapter-Update: 3.3; 4.3.; 4.4.2; 5.2.1.1 |
| 1.3 | New Chapter: 1.7.1 Chapter-Update: 1.5; 2.1.2; 4.3; 4.4.2; 8.2 |
| 1,2 | Chapter-Update: 4.4.2; 4.5, 4.6, 4.7; 4.8.4, 5.1.1, 5.1.3; 5.2.1, 5.3 |
| 1,1 | New Chapter: 4.7; 5.1.3; 5.3 Chapter-Update: 1.8; 2.2; 3.1; 3.2; 4.5; 4.6; 4.8; 4.9; 5.1.1; 5.2 |
| 1,0 | First edition |

1.7 Appropriate use

The servo drives of the AX5000 series are **exclusively** designed for torque, speed and position control of suitable asynchronous and synchronous three-phase current motors. The maximum permissible effective motor voltage must be at least equal the effective mains voltage fed into the servo drive.

The servo drives from the AX5000 series are designed for installation as components in electrical systems or machines and may be operated only as integrated system or machine components.

| | |
|---|--|
|  WARNING | Caution – Risk of injury! Electronic equipment is not fail-safe. The machine manufacturer is responsible for ensuring that the connected motors and the machine are brought into a safe state in the event of a fault in the drive system. |
|---|--|

The servo drives may **only** be operated in enclosed control cabinets and in accordance with the conditions described in the "Technical data" section.

1.7.1. Dual Use (EU 1382/2014)

As published on December 30, 2014 by EU Commission Delegated Regulation 1382/2014, standard frequency inverters – and with that also Beckhoff products AX5000 – become newly classified Dual-Use items: the item list Annex I of the Dual-Use Council Regulation 428/2009 has been changed accordingly, Frequency inverters (listed in item position 3A225) with a „rotation field frequency of 600 Hz or more“ are now

export controlled items. As a consequence some modifications have to be noticed.

Firmware versions without extension “Dual-Use conform” can be used in consideration of Hardware Versions with following drives only:

- HW Version 1.0 (AX5xxx-0000-x0xx): Serial Number < 68.000
- HW Version 2.0 (AX5xxx-0000-x20x) : Serial Number < 140.000
- HW Version 2.0 (AX5xxx-0000-x21x)

This firmware versions allow operation > 600 Hz rot. field frequency, shipment as single part may be subject to export control regulations.

Firmware versions with extension “Dual-Use conform” can be used in consideration of Hardware Versions with all drives. These versions support both rotational field frequency bands (<600 Hz, >= 600 Hz) depending on product hardware.

For products with option „x21x“, shipment as single part may be subject to export control regulations.

1.8 Documented servo drives

This documentation describes the following servo drives in the AX5000 range:

AX5160
AX5172
AX5190
AX5191
AX5192
AX5193

Notes :

2 Safety

2.1 General safety instructions

2.1.1 Safety rules

Consider the following safety instructions and descriptions!







Product specific safety instructions are to be found on the following pages or in the areas mounting, wiring, commissioning etc..

2.1.2 Disclaimer

All the components are supplied in particular hardware and software configurations appropriate for the application. Modifications to hardware or software configurations other than those described in the documentation are not permitted, and nullify the liability of Beckhoff Automation GmbH & Co. KG.

2.1.3 Description of safety symbols

The following safety symbols with a adjoining safety advise are used in this manual. You have to read the adjoining safety advice carefully and adhere it strictly.

| | |
|--|---|
|  DANGER | Acute risk of injury! If you do not adhere the safety advise adjoining this symbol, there is immediate danger to life and health of individuals! |
|  WARNING | Risk of injury! If you do not adhere the safety advise adjoining this symbol, there is danger to life and health of individuals! |
|  CAUTION | Hazard to individuals! If you do not adhere the safety advise adjoining this symbol, there is obvious hazard to individuals! |
|  Attention | Hazard to devices and environment If you do not adhere the notice adjoining this symbol, there is obvious hazard to materials and environment. |
|  Note | Note or pointer This symbol indicates information that contributes to better understanding. |
|  | UL pointer This symbol indicates important information about the UL-compliant. |




2.1.4 Personnel qualification


This description is only intended for trained specialists in control, automation and drive engineering who are familiar with the applicable national standards.


2.2 Special safety instructions for AX5000

The safety instructions are designed to avert danger and must be followed during installation, commissioning, production, troubleshooting, maintenance and trial or test assemblies.

The servo drives of the AX5000 series are not designed for stand-alone operation and must always be installed in a machine or system. After installation the additional documentation and safety instructions provided by the machine manufacturer must be read and followed.

| | |
|---|---|
|  <p>WARNING</p> | <p>Serious risk of injury through high electrical voltage!</p> <ul style="list-style-type: none"> • Never open the servo drive when it is live. Wait until the DC link capacitors are discharged. The voltage measured between the “ZK+ and ZK-” and “RB+ and “RB-” terminals must have fallen below 50 V. Opening the device (with the exception of expansion card slots) invalidates all warranty and liability claims against Beckhoff Automation. • Negligent, improper handling of the servo drive and bypassing of the safety devices can lead to personal injury or death through electric shock. • Ensure that the protective conductor is connected properly. • Disconnect the servo drive from the mains supply and secure it against reconnection before connecting or disconnecting the pluggable terminals. • Disconnect the servo drive from the mains supply and secure it against reconnection before working on electrical parts with a voltage > 50 V. • Due to the DC link capacitors dangerous voltage may persist at the DC link contacts “ZK+ and ZK-” and “RB+ and RB-” after the servo drive has been disconnected from the mains supply. After disconnecting the servo drive wait at AX5160/AX5172 15 minutes, at AX5190/AX5191 30 minutes and at AX5192/AX5193 45 minutes and measure the voltage at the DC link contacts ZK+ and ZK-. The device is safe once the voltage has fallen below 50 V. |
|  <p>WARNING</p> | <p>Serious risk of injury through hot surfaces!</p> <ul style="list-style-type: none"> • The surface temperature may exceed 50 °C, resulting in a risk of burns. • Avoid touching the case during or shortly after operation. • Leave the servo drive to cool down for at least 15 minutes after it is switched off. • Use a thermometer to check whether the surface has cooled down sufficiently. |
|  <p>WARNING</p> | <p>Danger of injury due to uncontrolled movements!</p> <p>Read and take note of chapter 6 ‘Important information for commissioning’ each time before commissioning the AX5000</p> |

| | |
|--|--|
|  CAUTION | Hazard to individuals! <ul style="list-style-type: none">• Carefully read this manual before using the servo drive thoroughly, paying particular attention to the safety instructions. In the event of any uncertainties please notify your sales office immediately and refrain from working on the servo drive.• Only well trained, qualified electricians with sound knowledge of drive equipment may work on the device.• During the electrical installation it is essential to ensure that the correct fuses/protective circuit breakers are used between the mains supply and the servo drive. Further information can be found in the "Electrical installation" section.• If a servo drive is installed in a machine it must not be commissioned until proof of compliance of the machine with the latest version of the EC Machinery Directive has been provided. This includes all relevant harmonised standards and regulations required for implementation of this Directive in national legislation. |
|--|--|

| | |
|---|---|
|  Attention | Hazard to devices and environment <ul style="list-style-type: none">• During installation it is essential to ensure that the specified ventilation clearances and climatic conditions are adhered to. Further information can be found in the "Technical data" and "Mechanical installation" sections.• If the servo drive is operated in contaminated ambient air, the cooling openings must be checked regularly for blockage. These checks should be carried out several times per day.• The servo drives contain components at risk from electrostatic discharge caused by improper handling:<ul style="list-style-type: none">- Please ensure you are electrostatically discharged before touching the servo drive directly.- Avoid contact with highly insulating materials (synthetic fibres, plastic film etc.).- Place the servo drive on a conductive surface. |
|---|---|

3 Guidelines and Standards


3.1 CE conformity

The servo drives **AX5160, AX5172, AX5190, AX5191, AX5192 and AX5193** comply with the

- EC Low-Voltage Directive, 2006/95/EC

Applied harmonised standards:

61800-5-1

| | |
|---|---|
|  CAUTION | Hazard to individuals! Servo drives are not covered by the EC Machinery Directive. Operation of the servo drives in machines or systems is only permitted once the machine or system manufacturers has provided evidence of CE conformity of the complete machine or system. |
|---|---|

3.2 Electromagnetic compatibility

The servo drives **AX5160, AX5172, AX5190, AX5191, AX5192 and AX5193** comply with the

- 2004/108/EC EMC Directive

Applied harmonised standards:

IEC / EN 61000-4-2

IEC / EN 61000-4-3

IEC / EN 61000-4-4

IEC / EN 61000-4-5

IEC / EN 61000-4-6

IEC / EN 61000-6-1

IEC / EN 61000-6-2


IEC / EN 61000-6-3

IEC / EN 61000-6-4

IEC / EN 61800-3

3.3 UL-Listing in USA and Canada

The following servo drives from the AX5000 series have a UL-Listing and must bear the CUS symbol

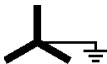
| | |
|--|--|
|  | AX5000 with UL-Listing AX5160, AX5172, AX5190, AX5191, AX5192 und AX5193 |
|--|--|

on the name plate. If you wish to operate an AX5000 in USA or Canada, please check that there is a CUS symbol on the name plate.

Below is a list of the relevant chapters that are amended with respect to the UL-Listing. Furthermore, UL-specific remarks are listed. It is essential to observe these specifications.


3.3.1 UL-specific chapter changes

“5.2.1 Mains supply connection (X01)”



AX5000 shall be connected only to a **grounded wye-source** where the maximum voltage does not exceed 277 V to ground.

“5.2.3 Connection of several servo drives to form a drive system”

| | |
|--|--|
|  | Drive system with UL-Listing! Please consult our Application Department with respect to the requirements for a drive system with UL-Listing. |
|--|--|

3.3.2 UL-specific chapter

“5.2.1.3 External protection, UL-compliant”

Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the Manufacture Instructions, National Electrical Code and any additional local codes.

AX5160 and AX5172:

Suitable for use on a circuit capable of delivering not more than 5000 rms symmetrical amperes, 480 V maximum. When protected by RK5 class fuses, rated 100 A maximum.

AX5190 - AX5193:

Suitable for use on a circuit capable of delivering not more than 10000 rms symmetrical amperes, 480 V maximum. When protected by RK5 class fuses, rated 225 A maximum.

| Fusing | AX5160 | AX5172 | AX5190 | AX5191 | AX5192 | AX5193 |
|---------------------|------------|--------|--------|--------|--------|--------|
| AC supply (max.) *) | | | | | | |
| 24 V supply (max.) | 4 AT | | 10 AT | | | |
| Brake resistor | electronic | | | | | |

*) Mains fuses according to type “RK5” min. 480 V must be used.

3.3.3 UL-specific notes


Use in a Pollution Degree 2 environment

Use 75 °C Copper Conductors min.

Control Board rating = 24 V

Drive intended for use over a range of motor sizes. Internal motor overload protection level is adjustable:

The internal motor protection is parameterised via the IDN P-0-0062 “Thermal motor model”, based on the value of the IDN S-0-0111 “Motor continuous stall current”. The IDN P-0-0062 “Time constant” is specified by the motor manufacturer and must be entered here. The IDN P-0-0062 “Warning limit” (Default) is responsible for deciding when a warning is to be generated. The IDN P-0-0062 “Error limit” (Default) is responsible for deciding when the motor is to be switched off. The default values take into account the specific characteristics of the servomotors.

| | |
|--|--|
|  | <p>Canada!</p> <p>In Canada use only in combination with unit AX2090-TS50, manufactured by Beckhoff Automation.</p> |
|--|--|

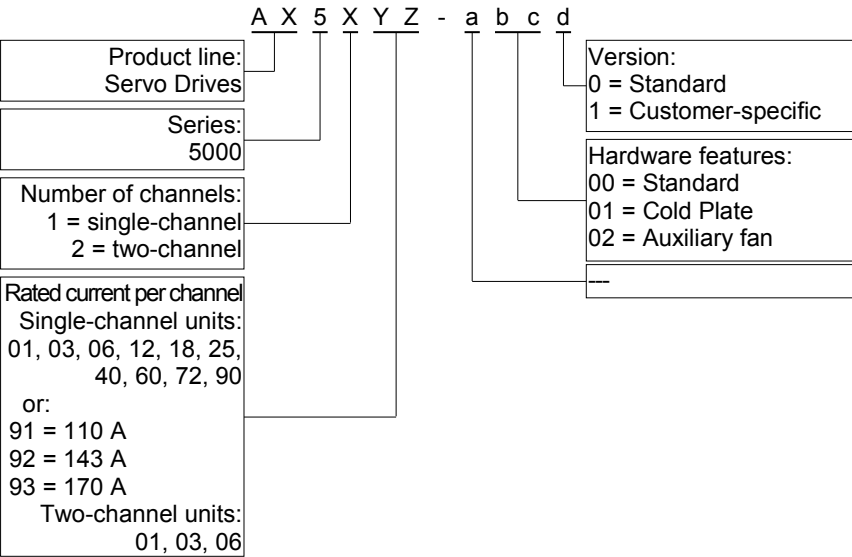
3.4 Electrical isolation according to EN 50178 / VDE 160

The power section (motor connection, DC link connection and mains connection) and the control unit are **doubly** insulated against each other, so that safe protection against accidental contact is ensured at all terminals of the control unit without additional measures. The air and creepage distances also meet the requirements of the above standard.

4 Product description

The servo drives of the AX5000 series are available as single- or multi-channel versions and are optimised in terms of function and cost-effectiveness. In conjunction with EtherCAT, the real-time Ethernet system, the integrated control technology offers minimum cycle times and supports fast, highly dynamic positioning tasks.

4.1 Type code



4.2 Scope of supply


The scope of delivery may vary depending on the ordered configuration. Before installing the device please ensure that all ordered components were delivered and that they are undamaged. In the event of any damage please contact the carrier immediately and document the damage.

4.2.1 Standard scope of supply

- AX5000 in the performance class according to the order
- Connectors for:
 - X03: DC power supply 24 V
 - X06: Digital inputs and outputs
 - X14: Motor temperature sensor and brake
- Startup (this manual)
- Complete documentation on CD

4.2.2 Accessories

A comprehensive list of accessories can be found in the complete Beckhoff catalogue or on our website at www.beckhoff.com.



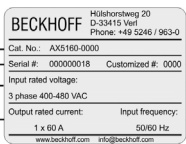
Accessories with UL-Listing!

If you wish to operate an AX5000 in an economic area that requires a UL-Listing, please make sure that the accessories also have a UL-Listing.

4.3 Name plate

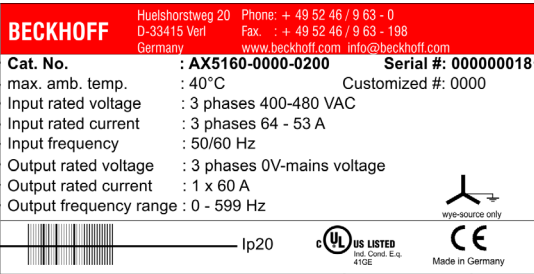
The servo drive features two name plates. A comprehensive name plate can be found on the right-hand side. An extract showing the main data can be found at the top of the servo drive.

1
2
3
7

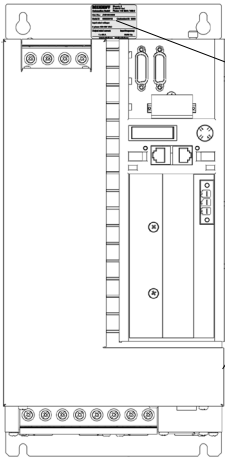


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Small name plate

Large name plate

| | | | | | |
|---|--------------------------|----|------------------------|----|-------------------|
| 1 | Catalog number | 6 | Output rated voltage | 11 | Customer-specific |
| 2 | Max. ambient temperature | 7 | Output rated current | 12 | wye-source only |
| 3 | Input rated voltage | 8 | Output frequency range | 13 | CE-Conform |
| 4 | Input rated current | 9 | Protection class | 14 | cULus - Listed |
| 5 | Input frequency | 10 | Serial number | | |

4.4 Technical data

| | |
|--|---|
|  | UL-Listing! It is essential to observe chapter 3.3 if you wish to operate an AX5000 in an economic area that requires a UL-Listing. |
|--|---|

4.4.1 Permissible ambient and operating conditions

| Ambient / operating conditions | Permissible values |
|--------------------------------------|---|
| Ambient temperature during operation | 0 °C up to +40 °C Up to 55 °C with reduced power (2 % / °C) |
| Ambient temperature during transport | -25 °C up to +70 °C |
| Ambient temperature during storage | -25 °C up to +55 °C |
| Air humidity | 15 % up to 85 %, non-condensing |
| Pollution degree | 2 according to EN 60664-1 |
| Corrosion protection | Normally not required. Under extreme operating conditions separate measures must be agreed with the manufacturer. |
| Operating altitude | up to 1000 m above sea level without reduced power. Between 1000 m and max. 2000 m with reduced power 1 % per 100 m. |
| Installation position | vertical |
| Ventilation | Built-in temperature-controlled fan |
| Protection class | IP 20 except the terminals (IP00) |
| EMC | Category C3 - standard Category C2, C1 - auxiliary filter required |

4.4.2 Electrical data

| Electrical Data | AX5160 | AX5172 | AX5190 | AX5191 | AX5192 | AX5193 |
|--|--------------------------------------|------------|--------------|--------|---------|---------|
| Rated output current ⁽¹⁾ | 60 A | 72 A | 90 A | 110 A | 143 A | 170 A |
| Minimum rated motor current at full current resolution | 25 A | 40 A | 50 A | 60 A | 70 A | 80 A |
| Peak output current ⁽²⁾ | 120 | 144 | 180 | 180 | 215 | 221 |
| Rated supply voltage | 3x 400-10% – 480+10% V _{AC} | | | | | |
| Max. DC link voltage | 890 V _{DC} | | | | | |
| Rated apparent power S1-mode (selection) | | | | | | |
| 400 V | 42 kVA | 50 kVA | 62 kVA | 76 kVA | 99 kVA | 118 kVA |
| 480 V | 45 kVA | 54 kVA | 67 kVA | 82 kVA | 107 kVA | 127 kVA |
| Power dissipation ⁽³⁾ | 830 W | 1010 W | 1300 W | 1600 W | 2100 W | 2500 W |
| Min. brake resistor] (external brake resistor) | 13 Ω | 13 Ω | 10 Ω | 10 Ω | 6,5 Ω | 6,5 Ω |
| Max. braking power (external brake resistor) | 52 kW | 52 kW | 67 kW | 67 kW | 103 kW | 103 kW |
| Mains choke ⁽⁴⁾ | | | AX2090-ND50- | | | |
| | --- | --- | 0090 | 0110 | 0143 | 0170 |
| Mains filter ⁽⁴⁾ | AX2090-NF50 | | | | | |
| | integrated | integrated | 0100 | 0150 | 0150 | 0180 |

⁽¹⁾ The rated current must be reduced by 10% when connecting rated voltage of 480V.

The specified values are valid for output rotary frequency > 5Hz

⁽²⁾ I_{eff} for max. 3 s at max. 70% preload of rated current

⁽³⁾ S1 mode, incl. power supply unit, without brake chopper

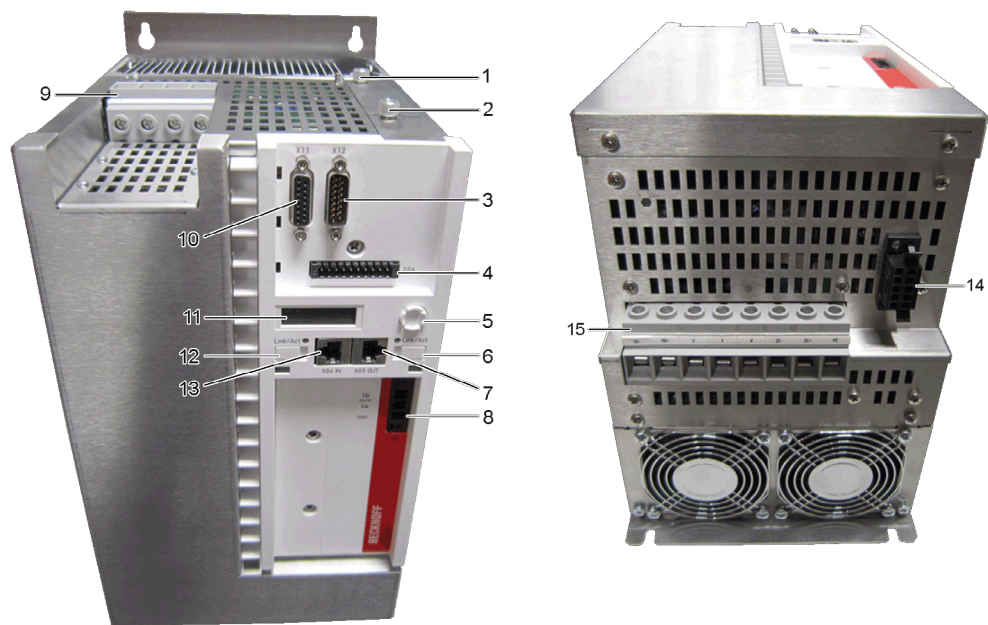
⁽⁴⁾ Required according to EN61800-3 (EMC product standard) C3 (industrial environment) with motor cable length max. 25 m.

4.4.3 Mechanical data

| Mechanical data | AX5160 | AX5172 | AX5190 | AX5191 | AX5192 | AX5193 |
|--|----------|----------|----------|----------|----------|----------|
| Weight | ca.14 kg | ca.14 kg | ca.31 kg | ca.31 kg | ca.38 kg | ca.38 kg |
| Breite Width | 190 mm | | 283 mm | 283 mm | 283 mm | 283 mm |
| Height without plugs | 345 mm | | 540 mm | 540 mm | 540 mm | 540 mm |
| Depth without connectors/ accessories | 259 mm | | 253 mm | 253 mm | 334 mm | 334 mm |

4.5 General overview (AX5160 and AX5172)

The servo drive illustrated below is an AX5172; the AX5160 is structurally similar




Item description:

| No | | Designation | No | | Designation |
|----|---|-------------|----|--|-------------|
| 1 | X4x – optional slot for expansion cards | | 9 | X01 – mains supply 400 – 480 V | |
| 2 | X3x – optional slot for safety card | | 10 | X12 – feedback connection, encoder | |
| 3 | X11 – feedback connection, resolver | | 11 | Display | |
| 4 | X06 – connection for digital inputs and outputs | | 12 | Labeling field | |
| 5 | Navigation rocker | | 13 | X04 – socket for EtherCAT input | |
| 6 | Labeling field | | 14 | X14 – sensor for motor temperature and brake | |
| 7 | X05 – socket for EtherCAT output | | 15 | Connection for external brake resistor | |
| 8 | X03 – power supply 24 V DC input | | | DC link output (890 V DC voltage) | |
| | <div><div><div><div><div></div><div></div></div><div><div></div><div></div></div></div><div><div></div><div></div></div></div><div>DANGER</div></div> <div>Max. 890 V DC voltage at the DC link terminals. Dangerous voltage may be present for 15 minutes after the device is switched off. The device is safe once the voltage has fallen below 50 V. (Check voltage)</div> | | | Motor connection (U,V,W,PE) | |

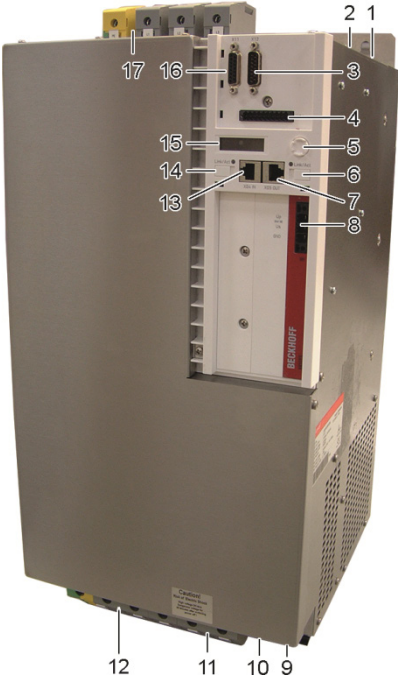
4.6 General overview (AX5190 and AX5191)




Item description:

| No | Designation | No | Designation |
|----|--|----|---|
| 1 | X4x – optional slot for expansion cards | 9 | X14 – sensor for motor temperature and brake |
| 2 | X3x – optional slot for safety card | 10 | DC link output (890 V DC voltage) Connection for external brake resistor |
| 3 | X11 – feedback connection, resolver | 11 | Motor connection (U,V,W,PE) |
| 4 | X06 – connection for digital inputs and outputs | 12 | X04 – socket for EtherCAT input |
| 5 | Navigation rocker | 13 | Labeling field |
| 6 | Labeling field | 14 | Display |
| 7 | X05 – socket for EtherCAT output | 15 | X12 – feedback connection, encoder |
| 8 | X03 – power supply 24 V DC input | 16 | X01 – mains supply 400 – 480 V |
| | <div> DANGER</div> <div>Max. 890 V DC voltage at the DC link terminals. Dangerous voltage may be present for 30 minutes after the device is switched off. The device is safe once the voltage has fallen below 50 V. (Check voltage)</div> | | |

4.7 General overview (AX5192 and AX5193)



Item description:

| No | Designation | | No | Designation | |
|----|--|--|----|--|--|
| 1 | X4x – optional slot for expansion cards | | 9 | X14 – sensor for motor temperature and brake | |
| 2 | X3x – optional slot for safety card | | 10 | X07 – External brake resistor | |
| 3 | X11 – feedback connection, resolver | | 11 | DC link output (890 V DC voltage) | |
| 4 | X06 – connection for digital inputs and outputs | | 12 | Motor connection (U,V,W,PE) | |
| 5 | Navigation rocker | | 13 | X04 – socket for EtherCAT input | |
| 6 | Labeling field | | 14 | Labeling field | |
| 7 | X05 – socket for EtherCAT output | | 15 | Display | |
| 8 | X03 – power supply 24 V DC input | | 16 | X12 – feedback connection, encoder | |
| | <div> DANGER</div> | Max. 890 V DC voltage at the DC link terminals. Dangerous voltage may be present for 45 minutes after the device is switched off. The device is safe once the voltage has fallen below 50 V. (Check voltage) | 17 | X01 – mains supply 400 – 480 V | |

4.8 Overview of connectors/terminal points

4.8.1 X01 – voltage input

4.8.1.1 AX5160 and AX5172



| Terminal point | Connection |
|----------------|----------------------|
| L1 | Phase L1 |
| L2 | Phase L2 |
| L3 | Phase L3 |
| PE | Protective conductor |

4.8.1.2 AX5190 and AX5191





| Terminal point | Connection |
|----------------|----------------------|
| L1 | Phase L1 |
| L2 | Phase L2 |
| L3 | Phase L3 |
| PE | Protective conductor |

4.8.1.3 AX5192 and AX5193



| Terminal point | Connection |
|----------------|----------------------|
| L1 | Phase L1 |
| L2 | Phase L2 |
| L3 | Phase L3 |
| PE | Protective conductor |

4.8.2 X07 – External brake resistor

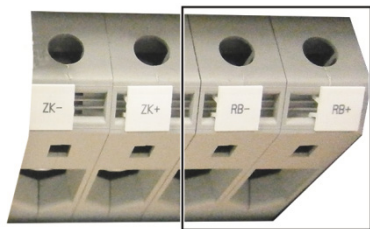
| | |
|--|---|
|  <p>Attention</p> | <p>Hazard to devices</p> <p>Connect the PE connection of the external brake resistor at the central grounding bar.</p> |
|  <p>DANGER</p> | <p>Serious risk of injury through high electrical voltage!</p> <p>890 V DC voltage at the RB+ and RB- terminals. Dangerous voltage may be present at AX5160/AX5172 for 15 minutes, at AX5190/AX5191 for 30 minutes and at AX5192/AX5193 for 45 minutes after the device is switched off (Check voltage).</p> |

4.8.2.1 AX5160 and AX5172



| Terminal point | Connection |
|----------------|---------------------------|
| RB + | External brake resistor + |
| RB - | External brake resistor - |

4.8.2.2 AX5190 and AX5191



| Terminal point | Connection |
|----------------|---------------------------|
| RB + | External brake resistor + |
| RB - | External brake resistor - |

4.8.2.3 AX5192 and AX5193



| Terminal point | Connection |
|----------------|---------------------------|
| RB + | External brake resistor + |
| RB - | External brake resistor - |

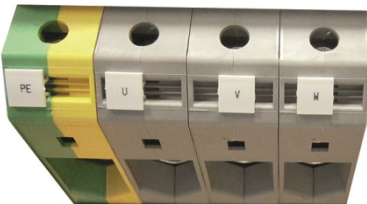
4.8.3 X13 – Motor connection

4.8.3.1 AX5160 and AX5172



| Terminal point | Connection |
|----------------|----------------------|
| U | Motor connection U |
| V+ | Moto connection V |
| W | Motor connection W |
| PE | Protective conductor |

4.8.3.2 AX5190 and AX5191




| Terminal point | Connection |
|----------------|----------------------|
| U | Motor connection U |
| V+ | Moto connection V |
| W | Motor connection W |
| PE | Protective conductor |

4.8.3.3 AX5192 and AX5193



| Terminal point | Connection |
|----------------|----------------------|
| U | Motor connection U |
| V+ | Moto connection V |
| W | Motor connection W |
| PE | Protective conductor |


4.8.4 X02 – DC link system (currently not permissible!)



Attention

Destruction of the AX5000!

The DC link connection is currently not permissible.



DANGER

Serious risk of injury through high electrical voltage!

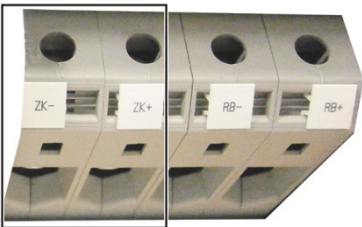
890 V DC voltage at the DC link terminals. Dangerous voltage may be present at AX5160/AX5172 for 15 minutes, at AX5190/AX5191 for 30 minutes and at AX5192/AX5193 for 45 minutes after the device is switched off (Check voltage).

4.8.4.1 AX5160 and AX5172



| Terminal point | Connection | |
|----------------|------------|----------------------------|
| ZK + | Zk + | Currently not permissible! |
| ZK – | Zk – | |

4.8.4.2 AX5190 and AX5191



| Terminal point | Connection | |
|----------------|------------|----------------------------|
| ZK + | Zk + | Currently not permissible! |
| ZK – | Zk – | |

4.8.4.3 AX5192 and AX5193



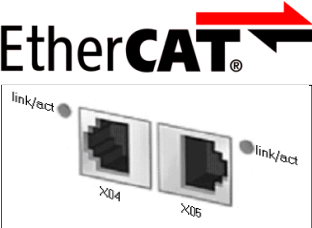
| Terminal point | Connection | |
|----------------|------------|----------------------------|
| ZK + | Zk + | Currently not permissible! |
| ZK – | Zk – | |

4.8.5 X03 – 24 V_{DC} supply



| Terminal point | Connection | Current consumption |
|------------------|--|---|
| U _p + | 24 V _{DC} -0/+25% - periphery (e.g. separate braking voltage) | Depending on the connected consumers (see X06 and X14, X24) |
| U _s + | 24 V _{DC} ±25% - system supply | 60 A-72 A = 3 A 90 A-170 A = 10 A |
| GND | GND | |

4.8.6 X04, X05 – EtherCAT connection



| Terminal point | Connection |
|----------------|------------------------|
| X04 (IN) | incoming EtherCAT line |
| X05 (OUT) | outgoing EtherCAT line |

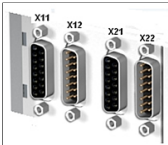
4.8.7 X06 – Digital I/Os

| | |
|--|---|
| | Destruction of the AX5000! This connector is not designed for external power supply. It is supplied via the 24 V supply (U _p) of connector X03. |
| | Output current The specified output currents are maximum values. The actual values depend on your current configuration. |



| Terminal point | Connection | Output current |
|----------------|---|----------------|
| 24 | Output voltage (U_p 24 V_{DC} +) | 1 A max. |
| 0 | Input 0 | |
| 1 | Input 1 | |
| 2 | Input 2 | |
| 3 | Input 3 | |
| 4 | Input 4 | |
| 5 | Input 5 | |
| 6 | Input 6 | |
| 7 | Input 7 or output (configurable) (U_p 24 V_{DC} +) | 0.5 A max. |
| 0 V | Output voltage GND (-) | |

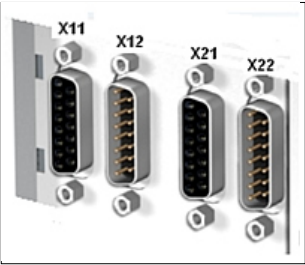
4.8.8 X11 – feedback, high-resolution



| Pin | EnDAT / BiSS | Hiperface | Sin / Cos 1Vpp | TTL |
|-----|-------------------------|-------------------------|-------------------------|-------------------------|
| 1 | SIN + | SIN + | SIN + | n.c. |
| 2 | GND_5 V | GND_9 V | GND_5 V | GND_5 V |
| 3 | COS + | COS + | COS + | n.c. |
| 4 | U_s 5 V ^{*)} | n.c. | U_s 5 V ^{*)} | U_s 5 V ^{*)} |
| 5 | DX + (Data) | DX + (Data) | n.c. | B + |
| 6 | n.c. | U_s 9 V ^{*)} | n.c. | n.c. |
| 7 | n.c. | n.c. | REF Z | REF Z |
| 8 | CLK + (Clock) | n.c. | n.c. | A + |
| 9 | REFSIN | REFSIN | REFSIN | n.c. |
| 10 | GND_Sense | n.c. | GND_Sense | GND_Sense |
| 11 | REF COS | REF COS | REF COS | n.c. |
| 12 | U_s 5 V Sense | n.c. | U_s 5 V Sense | U_s 5 V Sense |
| 13 | DX - (Data) | DX - (Data) | n.c. | B - |
| 14 | n.c. | n.c. | Z + | Z + |
| 15 | CLK - (Clock) | n.c. | n.c. | A - |

^{*)} The max. output current per channel is 0,25 A

4.8.9 X12 – resolver/hall



| Pin | Feedback system | |
|-----|--|----------------------------|
| | Resolver | Analog Hall sensor |
| 1 | Temperature (only PTC, Klixon or bimetal!) Switchpoint: 1300 Ω ± 3% | n.c. |
| 2 | AGND | n.c. |
| 3 | COS - (S3) | n.c. |
| 4 | SIN - (S4) | n.c. |
| 5 | REF - (R2) | n.c. |
| 6 | n.c. | SIN 1Vpp |
| 7 | n.c. | -120° oder -90° 1Vpp * |
| 8 | n.c. | Us_9 V (supply) |
| 9 | Temp. GND | n.c. |
| 10 | COS + (S1) | n.c. |
| 11 | SIN + (S2) | n.c. |
| 12 | REF + (R1) | n.c. |
| 13 | n.c. | REFSIN 1 Vpp |
| 14 | n.c. | REF -120° oder -90° 1Vpp * |
| 15 | n.c. | GND (supply) |

*) The angle must be configured

4.8.10 X14 – motor brake and thermal contact



| Terminal point | Connection | Output current |
|----------------|---------------------------|----------------|
| T- | Temp. - * | |
| T+ | Temp. + * | |
| PE | Signal pair screen | |
| B- | Brake GND | |
| B+ | Brake (U _p) + | 2.2 A max. |

*) Switch, KTY 83-1xx or KTY 84-1xx

Note

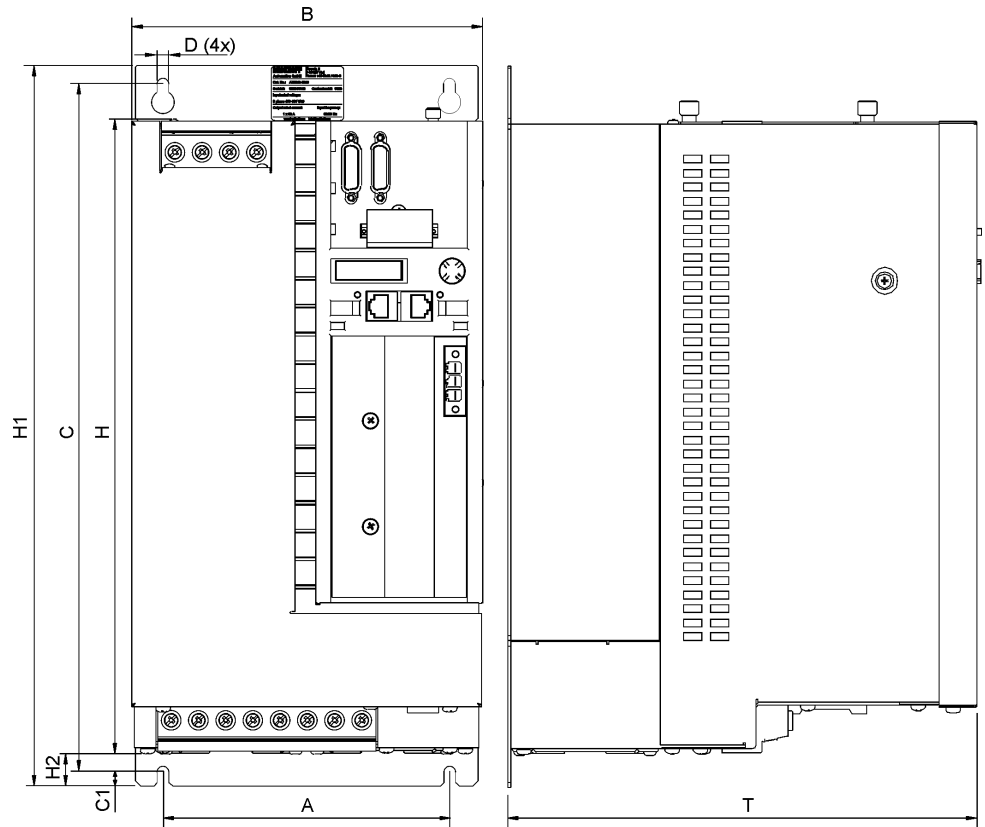
Output current

The specified output current is the maximum value. The actual value depends on your current configuration.

4.9 Dimensions


The specified measurements relate to the actual device, without connectors and cables. The fitting dimensions for control cabinet installation can be found in section "Mechanical installation → Installation examples".


AX5160, AX5172, AX5190, AX5191, AX5192, AX5193




| AX | A [mm] | B [mm] | C [mm] | C1 [mm] | D [mm] | H [mm] | H1 [mm] | H2 [mm] | T [mm] | Fastening screw |
|------|-----------|-----------|-----------|------------|-----------|-----------|------------|------------|-----------|--------------------|
| 5160 | 158 | 190 | 380 | 8 | 6,5 | 345 | 398 | 16,5 | 259 | 4 x M5 |
| 5172 | 158 | 190 | 380 | 8 | 6,5 | 345 | 398 | 16,5 | 259 | 4 x M5 |
| 5190 | 200 | 280 | 582 | 10 | 9 | 540 | 603 | 10 | 254 | 4 x M8 |
| 5191 | 200 | 280 | 582 | 10 | 9 | 540 | 603 | 10 | 254 | 4 x M8 |
| 5192 | 200 | 280 | 575 | 10 | 9 | 540 | 600 | 20 | 335 | 4 x M8 |
| 5193 | 200 | 280 | 575 | 10 | 9 | 540 | 600 | 20 | 335 | 4 x M8 |

5 Installation

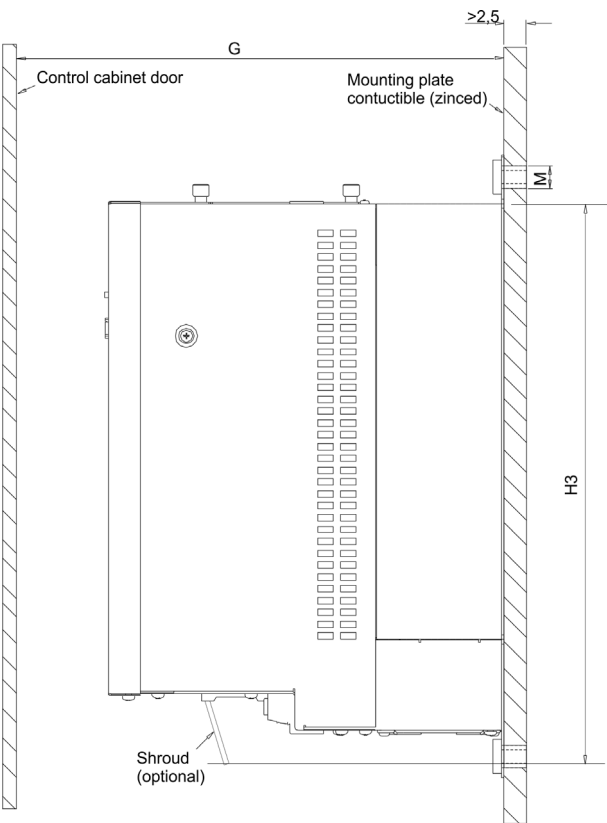
| | |
|--|---|
|  WARNING | Caution – Risk of injury! <ul style="list-style-type: none">• The servo drives may only be installed by trained, qualified personnel. The qualified personnel must know and comply with the national accident prevention regulations.• Safety boots must be worn. |
|--|---|

| | |
|--|---|
|  WARNING | Caution - Risk of injury through electric shock! <p>De-energise all electrical components (servo drive, control cabinet, etc.) before commencing the installation or deinstallation.</p> |
|--|---|


5.1 Mechanical installation

| | |
|---|---|
|  Attention | Destruction of the servo drive! <ul style="list-style-type: none">• Always install the servo drive vertically.• Provide adequate ventilation for the servo drive. The permissible ambient conditions are specified in the "Technical data" section.• It is essential to adhere to the required distances (see diagrams below). |
|---|---|

5.1.1 Installation in the control cabinet




| AX | G [mm] | M [mm] | H3 [mm] |
|---------------|-----------|-----------|------------|
| 5160 and 5172 | ≥ 300 | 4 x M5 | 445 |
| 5190 and 5191 | ≥ 300 | 4 x M8 | 640 |
| 5192 and 5193 | ≥ 500 | 4 x M8 | 640 |



WARNING

Caution - Risk of injury through electric shock!

The mounting plate must be earthed according to the statutory regulations.

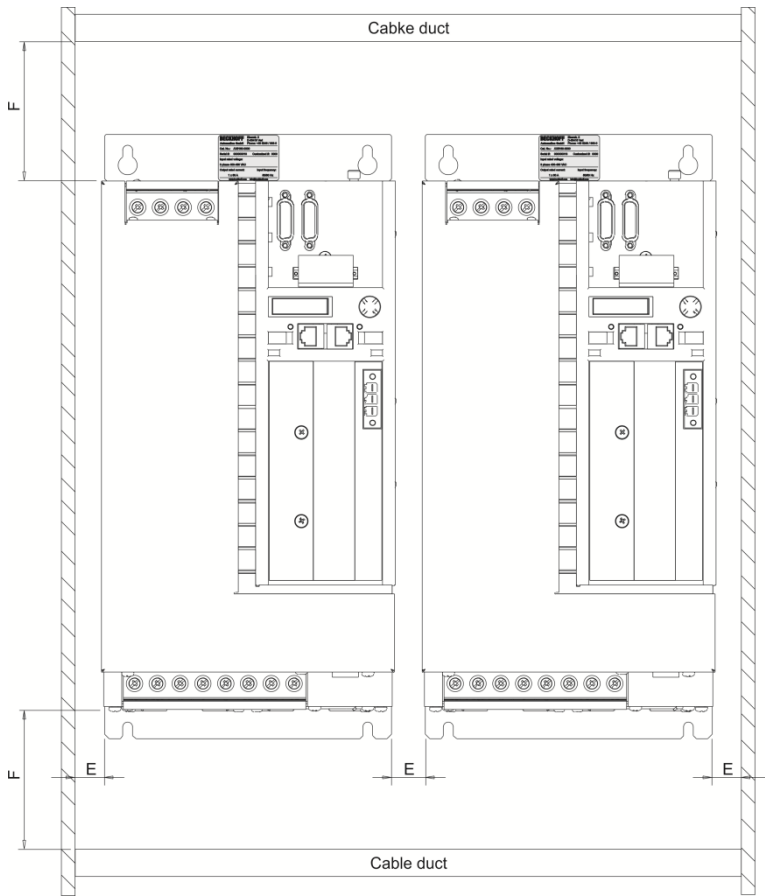


Attention

Grounding!

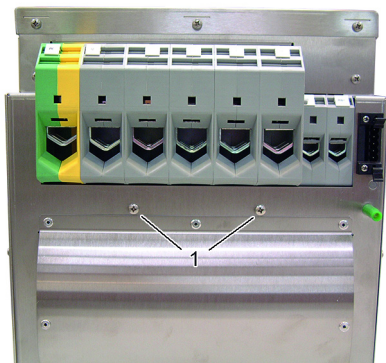
If the ground connection of the AX5000 is not done as specified it is possible to get trouble with some EMC issues.

5.1.2 Installation example

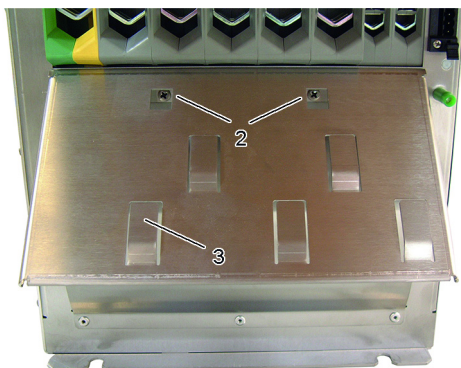


| AX | F [mm] | E [mm] |
|---------------|-----------|-----------|
| 5160 and 5172 | ≥ 180 | 20 |
| 5190 and 5191 | ≥ 180 | 40 |
| 5192 and 5193 | ≥ 180 | 40 |

5.1.3 Installation of the shroud (optional)







1. Remove the screws 1
(Don't use again.)



2. Position the shroud at the ground of the servo drive.
3. Mount the shroud with the screws 2.
(Take the new delivered screws.)


4. Connect the lines at the terminals.
5. Connect the shield of the lines at the connecting links 3.

5.2 Electrical installation

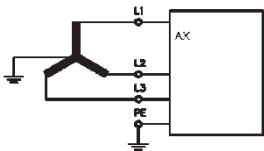
| | |
|--|---|
|  | <p>UL-Listing!</p> <p>It is essential to observe chapter 3.3 if you wish to operate an AX5000 in an economic area that requires a UL-Listing.</p> |
|  <p>DANGER</p> | <p>Serious risk of injury through electric shock!</p> <p>Due to the DC link capacitors dangerous voltage may persist at the DC link contacts "ZK+ and ZK-" and "RB+ and RB-" after the servo drive has been disconnected from the mains supply. After disconnecting the servo drive wait at AX5160/AX5172 15 minutes, at AX5190/AX5191 30 minutes and at AX5192/AX5193 45 minutes and measure the voltage at the DC link contacts ZK+ and ZK-. The device is safe once the voltage has fallen below 50 V.</p> |
|  <p>WARNING</p> | <p>Caution – Risk of injury through electric shock!</p> <ul style="list-style-type: none"> • Before installation, wiring and commissioning it is essential to read the section on "Safety". • Before installing, uninstalling or connecting the servo drive and the motors please note the following: <ul style="list-style-type: none"> - Remove all relevant mains fuses. - Switch off the main system switch and secure it with a lock. - Put up a warning sign. • The control and power connections for the motors may be live, even if the motor is prevented from rotating by the internal brake. |
|  <p>Attention</p> | <p>Destruction of the equipment!</p> <ul style="list-style-type: none"> • Check the rated voltage and current of the servo drive and the connected motors. • When the AX5000 is disconnected from the mains supply (emergency stop, mains contactor etc.), query the status of the IDN "P-0-0205" (see documentation of the "IDN-Description") before starting again or |

5.2.1 Mains supply connection (X01)


The servo drives of the AX5000 series are equipped with a wide voltage input "X01" and can be connected to voltage systems three-phase 400 V_{AC} -10% - 480 V_{AC} +10%.

| | |
|--|---|
|  Note | <p>Connection to the standard mains supply (TT/TN) with earthed centre is described below. Connections to other supply systems are not permissible.</p> |
|--|---|

Three-phase 400_{-10%} - 480_{+10%} V_{AC}




5.2.1.1 External protection for individual devices, CE-compliant

| | |
|---|--|
|  CAUTION | <p>Fire hazard through short circuit!</p> <p>The recommended fuses are designed for line protection. The servo drives feature integrated self-protection.</p> |
|---|--|

| Fusing | AX5160 | AX5172 | AX5190 | AX5191 | AX5192 | AX5193 |
|----------------|------------|--------|--------|--------|--------|--------|
| AC supply *) | 80 AT | 100 AT | 125 AT | 160 AT | 200 AT | 224 AT |
| 24 V supply | 4 AT | | 10 AT | | | |
| Brake resistor | electronic | | | | | |

*) Application class "gG" mains fuses according to IEC 60269 or "C" type automatic circuit breakers must be used.

5.2.1.2 External protection for individual devices, UL-compliant


| | |
|---|--|
|  CAUTION | <p>Fire hazard through short circuit!</p> <p>The recommended fuses are designed for line protection. The servo drives feature integrated self-protection.</p> |
|---|--|

| Fusing | AX5160 | AX5172 | AX5190 | AX5191 | AX5192 | AX5193 |
|---------------------|------------|--------|--------|--------|--------|--------|
| AC supply (max.) *) | | | | | | |
| 24 V supply (max.) | 4 AT | | 10 AT | | | |
| Brake resistor | electronic | | | | | |

*) Mains fuses according to type "RK5" min. 480 V must be used.

5.2.2 24 V_{DC} - supply network connection (X03)

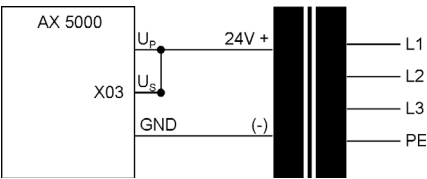
The 24 V_{DC} connection "X03" is used for supplying control electronics and periphery with DC voltage. The control electronics and the periphery can be supplied separately with two different voltage sources.



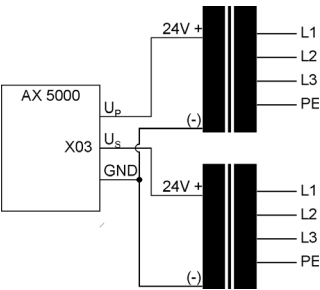
Note

If one transformer is used for the 24 V_{DC} power supply, the connections U_S and U_P must be bridged, in order to ensure that both the control electronics and the periphery are supplied.

Supply through via one transformer



Supply via two transformers



5.3 Motors and cables

With longer motor cables the resulting commutation currents can affect the control quality and lead to EMC faults. Use the tables below to check whether motor chokes or mains filters have to be used in your application. When selecting the control cabinet ensure that there is adequate space for motor chokes, mains filters, etc.

Lay the power and signal cables in separate metal cable ducts or, if both types of cable use the same metal cable duct, make sure there is an earthed metal dividing wall between the cables.



Note

Motor chokes

For the series AX5160 up to AX5193 motor chokes are not required.

Maximum cable length (including extensions) for a rated motor voltage up to 480 V

| Motor choke | AX5160 | | AX5172 | | AX5190 ¹⁾ | | AX5191 ²⁾ | | AX5192 ²⁾ | | AX5193 ³⁾ | |
|---------------------|--------|----|--------|----|----------------------|------|----------------------|------|----------------------|------|----------------------|------|
| | C2 | C3 | C2 | C3 | C2 | C3 | C2 | C3 | C2 | C3 | C2 | C3 |
| AX2090 ND50-0060 | 4) | 5) | - | - | - | - | - | - | - | - | - | - |
| AX2090 ND50-0072 | - | - | 4) | 5) | - | - | - | - | - | - | - | - |
| AX2090 ND50-0090 | - | - | - | - | 10 m | 25 m | - | - | - | - | - | - |
| AX2090 ND50-0110 | - | - | - | - | - | - | 10 m | 25 m | - | - | - | - |
| AX2090 ND50-0143 | - | - | - | - | - | - | - | - | 10 m | 25 m | - | - |
| AX2090 ND50-0170 | - | - | - | - | - | - | - | - | - | - | 10 m | 25 m |

¹⁾ For compliance with EN 61800-3 only with mains filter AX2090-NF50-0100.


²⁾ For compliance with EN 61800-3 only with mains filter AX2090-NF50-0150.

³⁾ For compliance with EN 61800-3 only with mains filter AX2090-NF50-0180.

⁴⁾ Without line choke up to max. 10m

⁵⁾ Without line choke up to max. 25m

6 Important information for commissioning


| | |
|--|---|
|  WARNING | <p>Caution – Risk of injury!</p> <p>Electronic equipment is not fail-safe. The machine manufacturer is responsible for ensuring that the connected motors and the machine are brought into a safe state in the event of a fault in the drive system.</p> |
|--|---|

Please be aware each time before commissioning the AX5000 that connected motors can make uncontrolled movements, which cannot always be prevented even by the AX5000's integrated diagnostic system, or may permit uncontrolled movements until the diagnostic system responds. Analyse your system and take suitable precautions to prevent damage being caused by these uncontrolled movements.

Potential causes of uncontrolled movements:

The diagnostic system of the AX5000 is equipped with complex plausibility checks, which constantly monitor installation, operation, parameterisation and operation and, if necessary, interrupt them with a diagnostic message. The points listed below are naturally also monitored as standard, but it is not possible to include all eventualities; therefore, with respect to the following points, you must always consider whether the driven axes can only perform permissible movements.

- Incorrect commutation results (e.g. during wake & shake), It is essential to observe chapter "AX5000 User manual→commissioning→commutation methods→commutation error "F2A0"" on our Homepage.
- **Specific caution with synchronous motors of third parties:** always execute the command „P-0-0166“ without load when changing the motor or feedback or when changing the SysMan-file (.TSM) and evaluate the result. Correct the commutation offset if applicable., as described in chapter "AX5000 User manual →Commissioning →Commutation methods".
- Input of invalid parameters
- Measuring transducer and/or signal transducer defective or incorrectly adjusted
- Cables defective or not adequately screened
- Incorrectly attached sensors

| | |
|--|--|
|  CAUTION | <p>Increased attention in the case of vertical axes!</p> <p>When commissioning vertical axes, the risk consideration described above is to be carried out with particular care. An uncontrolled movement can mean the sudden falling down of a load in this case.</p> |
|--|--|

7 Project planning – important information

The more thoroughly a machine or plant project is thought through in advance, the less risk there is of having to carry out expensive modifications during or after commissioning. This applies to both the mechanical and electrical design. This section can only give a rough overview of electrical design. Further information can be found in the publication "Project planning aid" under Downloads on our website at www.beckhoff.com

7.1 Drive train design

Application, servo drive, motors and gear mechanism must be adapted to each other so that there is an adequate safety margin for all components as a degree of sluggishness appears over time due to high temperatures or wear. Make sure that the components in the working area of the system have adequate reserves so that the working life is not impaired and the necessary control quality can be maintained.

7.1.1 Control quality, mass inertia ratio and load connection

Control quality is dependent on the parameters "mass inertia ratio" and "load connection":

| Control quality / Dynamics | Mass inertia ratio |
|----------------------------|--------------------|
| Good | up to 3:1 |
| Average | up to 5:1 |
| Bad | up to 10:1 |

The "Control quality / dynamics" is primarily affected by the mass moment of inertia: a poor "Control quality / dynamic" due to an unfavourable mass moment of inertia cannot be improved even with a very good load connection. Likewise, however, a good "Control quality / dynamic" due to a favourable mass moment of inertia can be reduced through a poor load connection.

7.2 Energy management

If the quality of the mains supply is impaired due to wide fluctuations in voltage, then both the servo drive specification and the speed range of the motor will need to be considered. With a positive tolerance for voltage fluctuation the upper limit value of the wide voltage input of the AX5000 needs to be taken into account. With a negative tolerance of the voltage fluctuation it must be checked whether the decrease in speed caused by the low voltage is permissible. With these motors what is known as field weakening operation (check availability) of the servo drive may provide a solution.

7.3 EMC, earthing, screen connection and potential

The AX5000 corresponds to EMC category "C3" (industrial sector) in terms of conducted interference emissions. If you wish to use components which comply with a higher category you can limit the AX5000 conducted interference emissions with the aid of additional filters to such a degree that this complies with the EMC category "C2" (residential and industrial environment) or "C1" (residential environments).

Ensure that there is adequate earthing (large-area low-impedance connection) of all relevant components (incl. control cabinet). The AX5000 incl. periphery, control cabinet, machine bed and motors must be at the same potential, as the AX5000 control quality will suffer under differing potentials and operational malfunction may result. Using the screen connection for potential equalisation is not permitted. If you are unable to provide a uniform reference potential you need to lay potential equalisation cables of adequate dimensions.

Smooth operation is only guaranteed by faultless screen connections of the cables. The screens must be applied generously at both ends and must on no account be disconnected. Use Beckhoff motor and feedback cables as these are optimally adapted to the drive system and reduce interference to a minimum. Ensure that the connectors and cables are properly connected.

7.4 Control cabinet

The dimensions of the control cabinet must be sufficient to accommodate all components with the specified distances. Remember that high temperatures may necessitate forced cooling. Position the control cabinet as close as possible to the machine so that the motor cables can be as short as possible.

In addition, the control cabinet should have an earthed metal rear panel to which the AX5000 incl. periphery are attached so that safe earthing can be guaranteed. If you are unable to guarantee these conditions you need to earth the AX5000 and the relevant components using an approved cable of adequate size.

8 Appendix

8.1 Support and Service

Beckhoff and their partners around the world offer comprehensive support and service, making available fast and competent assistance with all questions related to Beckhoff products and system solutions.

8.1.1 Beckhoff's branch offices and representatives

Please contact your Beckhoff branch office or representative for [local support and service](#) on Beckhoff products!

The addresses of Beckhoff's branch offices and representatives round the world can be found on her internet pages: <http://www.beckhoff.com>

You will also find further [documentation](#) for Beckhoff components there.

8.1.2 Beckhoff Headquarters

Beckhoff Automation GmbH & Co. KG
Hülshorstweg 20
33415 Verl
Germany

Phone: +49(0)5246/963-0

Fax: +49(0)5246/963-198

E-Mail: info@beckhoff.com

8.1.3 Beckhoff Support

Support offers you comprehensive technical assistance, helping you not only with the application of individual Beckhoff products, but also with other, wide-ranging services:

- Support
- Design, programming and commissioning of complex automation systems
- Extensive training program for Beckhoff system components

Hotline : +49(0)5246/963-157

Fax : +49(0)5246/963-9157

E-Mail : support@beckhoff.com

8.1.4 Beckhoff Service

The Beckhoff Service Center supports you in all matters of after-sales service:

- On-site service
- Repair service
- Spare parts service

Hotline : +49(0)5246/963-460

Fax : +49(0)5246/963-479

E-Mail : service@beckhoff.com